日本におけるイカリムシの新宿主と日本産イカリムシ科カイアシ類の目録(1915-2007年)

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New Host Records for *Lernaea cyprinacea* (Copepoda), a Parasite of Freshwater Fishes, with a Checklist of the *Lernaeidae* in Japan (1915-2007)

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Abstract The lernaeid copepod *Lernaea cyprinacea* Linnaeus, 1758, was found attached to three species of freshwater fishes, the barbell steed *Hemibarbus labeo* (Pallas) (Cyprinidae), the dark chub *Zacco temminckii* (Temminck and Schlegel) (Cyprinidae), and the Amur catfish *Silurus asotus* Linnaeus (Siluridae) from Hiroshima Prefecture in Japan. The findings from *Hemibarbus labeo* and *Zacco temminckii* represent new host records for *L. cyprinacea*, while *Silurus asotus* is a new host in Japan. Based on the literature published for 93 years from 1915 to 2007, a checklist of three species of lernaeid copepods (*Lernaea cyprinacea*, *Lernaea parasiluri*, *Lamproglena chinensis*) from Japan is given, including information on the synonym(s), host(s), site(s) of infection, and distribution. The checklist shows that in Japan *L. cyprinacea* has been reported from 33 or 34 species and subspecies of fishes belonging to 17 families in 10 orders and also from 2 species of amphibians from 2 families in 2 orders.

Key words: *Lamproglena chinensis*; *Lernaea cyprinacea*; *Lernaea parasiluri*; *Lernaeidae*; parasites; new hosts

INTRODUCTION

The lernaeid copepod *Lernaea cyprinacea* Linnaeus, 1758, often called the anchor worm, is a parasite of freshwater fishes in various regions of the world (Kabata, 1979; Lester and Hayward, 2006). The anterior part of the body of metamorphosed adult female is embedded in the host tissue, whereas the remaining body protrudes in the water. The species has nine stages in the life cycle, including three free-living naupliar stages, five copepodid stages, and one adult stage (Grabda, 1963). After male and female adults mate on the fish host and then males die, females metamorphose, insert their anterior body into the host tissue and then produce eggs. The copepod is known as a pathogen of cultured and aquarium fishes (Shariff et al., 1986; Lester and Hayward, 2006).

In Japan, various studies on the biology of *L. cyprinacea* have been conducted to date since the work of Ishii (1915) who recorded it as *Lerneocera cyprinacea*. The species was later described by Leigh-Sharpe (1925) as a new species, *Lernaea elegans* from the Japanese eel *Anguilla japonica* in central Japan, which was subsequently regarded by Harding (1950) as a junior synonym of *L. cyprinacea*. The copepod has been reported from a variety of host species including wild, aquarium, and cultured fishes and even amphibians in the country.

The present note deals with new host records for *L. cyprinacea* and provides a checklist of three
species of lernaeid copepods (*L. cyprinacea, Lernaea parasiluri, Lamproglena chinensis*) in Japan based on the literature (mostly written in Japanese) published between the years 1915 and 2007. Since *L. elegans* has been currently regarded as a valid species (see Kabata, 1979), it may be better to use this scientific name for the Japanese anchor worm. Following Harding (1950), however, we tentatively use *L. cyprinacea* in this note because we have not yet enough data to say whether both taxa are conspecific or not.

**MATERIALS AND METHODS**

The fishes infected with *L. cyprinacea* were collected in the Ashida River, Fukuyama, and the Kurose River, Higashi-Hiroshima, in Hiroshima Prefecture in October 2006 and June 2007, respectively. In the laboratory, the copepods were carefully removed from the hosts and preserved in 70% ethanol. They were examined whole on an Olympus microscope. Drawings were made with the aid of a drawing attachment.

**RESULTS AND DISCUSSION**

One young adult female (Fig. 1A) and 10 copepodids (Fig. 1B) of *Lernaea cyprinacea* were found attached to the gills of the barbell steed *Hemibarbus labeo* (Cyprinidae) (1 infected/22 examined) and the Amur catfish *Silurus asotus* (Siluridae) (1 infected/1 examined) from the Ashida River, respectively. The adult female was not ovigerous. The body was slender and 2.54 mm long. The cephalic holdfast comprised a pair of unbranched ventral processes and a pair of larger, slightly branched dorsal processes. The

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Fig. 1. *Lernaea cyprinacea* from freshwater fishes in Japan. A, a young adult female from the gills of *Hemibarbus labeo* from the Ashida River, habitus, dorsolateral; B, a copepodid V from the gills of *Silurus asotus* from the Ashida River, habitus, dorsal; C, a young adult female from the dorsal fin of *Zacco temmincki* from the Kurose River, habitus, dorsolateral. Scale bars: 0.5 mm in A and C; 0.1 mm in B.
copepodids were 0.70-1.15 (mean 0.93) mm long and all were at fifth stage.

One young adult female with egg sacs (Fig. 1C) of *L. cyprinacea* was collected from the dark chub *Zacco temminckii* (Cyprinidae) (1 infected/1 examined) in the Kurose River. The female was attached to the dorsal fin. The body was slender and 3.46 mm long. The cephalic holdfast was not well developed.

*Lernaea cyprinacea* is not host-specific and has a wide host range (Kabata, 1979; Shariff et al., 1986). According to Kabata (1979), the species has been recorded from over 100 fish species from 25 families in 10 orders. Even each in China and Japan, about 30 species of fishes are known as hosts of the copepod (see below). Nevertheless, the two cyprinid species, *Hemibarbus labeo* and *Zacco temminckii* are herein recorded as new hosts for *L. cyprinacea*. Also, *Silurus asotus* is a new host for the copepod in Japan, where the fish is also known as a host for a related species *Lernaea parasiluri* (Yamaguti, 1939).

*Lernaea cyprinacea* is found in other East Asian countries as well. In Korea, the species infects *Misgurnus anguillicaudatus*, *Carassius auratus*, *Pseudorasbora parva*, *Zacco platypus*, *Lepomis macrochirus*, *Channa argus* (as *C. arga*), *Cyprinus carpio*, *Micropterus salmoides* and *Hemiculter leucisculus* (Hontani, 1939; Kim and Choi, 2003). In Taiwan, it occurs on *Cyprinus carpio* and *Carassius auratus* (Ho, 1961; Chien, 1994). In China, the copepod has been reported from many freshwater fishes, including *Cyprinus carpio*, *C. megalophthalmus*, *Carassius auratus*, *Mylopharyngodon piceus*, *Hypophthalmichthys molitrix*, *Aristichthys nobilis*, *Culter erythropterus*, *Hemiculter leucisculus*, *Anabarilius songmingensis*, *Megalobrama terminalis*, *M. amblycephala*, *Ochetobius elongatus*, *Opsarichthys uncirostris bidens*, *Pseudorasbora parva*, *Acrossocheilus yunnanensis*, *Sinocyclocheilus malacopterus*, *Barbodes daliensis*, *Garra orientalis*, *Rhodeus sp.*, *Puntius semifasciolatus*, *Silurus asotus*, *Simperca chuati*, *Oryzias latipes*, *Tilapia mossambica*, *Fugu sp.*, *Ophiocephalus (=Channa) argus*, *Mastacembelus aculeatus*, *Macropodus chinensis*, *Misgurnus anguillicaudatus* and *Salmonidae* gen. sp. (as *Salmon sp.*) (Yin, 1962; Yin et al., 1963; Wang, 1964; Chen, 1973; Kuang and Qian, 1991). In Far Eastern Russia, the copepod was reported from *Cyprinus* sp. and *Percottus* sp. in the Amur River (Dogiel and Akhmerov, 1952).

**A CHECKLIST OF THE LERNAEIDAE IN JAPAN**

Three species of lernaeid copepods (*Lernaea cyprinacea*, *Lernaea parasiluri*, *Lamproglena chinensis*) so far have been reported from Japan. The following checklist is compiled based on the literature (including this paper) on these three species in this country published during a period from 1915 to 2007. The synonyms listed herein are those that have been used in establishing records of the species in Japan. The site of infection is the habitat of the copepod found on its host. The distribution in Japan of the copepod is indicated by prefecture (boundaries shown in Fig. 2), in geographical order from northeast to southwest. The authors responsible for the record(s) are listed in chronological order; each reference is followed by the locality or localities given in two parts, first the prefecture and then the detailed collection locality or localities from which the copepod was reported. For references in which a locality record was not given, the geographical locality is shown by a dash (−). The scientific names of the fishes listed below are mainly those recommended in Nakabo (2002). For the ornamental goldfish, *Carassius auratus* is used as its scientific name.

Family Lernaeidae Coddold, 1879 (イカリムシ科)

Genus *Lernaea* Linnaeus, 1758 (イカリムシ属)

*Lernaea cyprinacea* Linnaeus, 1758 (イカリムシ)
Synonyms: *Lerneocera cyprinacea* (Linnaeus, 1758); *Lernaea elegans* Leigh-Sharpe, 1925; *Lernaea (Lerneocera) elegans* Leigh-Sharpe, 1925

Includes: *Lernaea* sp. of Anonymous, 2002

Hosts (*: non-native species; **: non-native ornamental fish kept in aquaria)

Osteichthyes (硬骨魚類)

**: Lepisosteiformes (レピソステイロイド)

Lepisosteidae (レピソステイジン科)

**: Lepisosteidae gen. sp. (ガーバイク) [17]

Osteoglossiformes (オストゴラスイロイド)

Ostegoglossidae (オストゴラスイジン科)

**: *Arapaima gigas* (アルパインマ、ピラルクイ) [17]

Anguilliformes (アングリルイロイド)

Anguillidae (アングリルイジン科)

*Aristichthys nobilis* and/or *Hypophthalmichthys molitrix* (ヒラメシイギョ、キンギョ) [17]

**: *Carassius auratus* (カ grafish, キンギョ) [3, 5, 6, 9, 10, 11, 12, 14, 15, 17]

*Carassius auratus* langsdorfi (カ brink; キンブナ) [22]

**: *Carassius auratus* subsp. (as *Carassius auratus*) (クラニシ, ケンブリュウナ) [1, 2, 3, 5, 6, 15, 23]

*Carassius cuvieri* (オオニシ, ケンブリュウナ) [17]

**: *Ctenopharyngodon idellus* (グラシイギョ) [15, 17]

Cyprinidae (コイ科)

*Acheilognathinae* gen. sp. (bitterling, 「タナゴ」) [15, 17]

**: *Aristichthys nobilis* and/or *Hypophthalmichthys molitrix* (ヒラメシイギョ、キンギョ) [17]

**: *Carassius auratus* (カ grafish, キンギョ) [3, 5, 6, 9, 13, 14, 15, 21]

**: *Carassius auratus* langsdorfi (カ トマト; キンブナ) [22]

**: *Carassius auratus* subsp. (as *Carassius auratus*) (クラニシ, ケンブリュウナ) [1, 2, 3, 5, 6, 15, 23]

*Carassius cuvieri* (オオニシ, ケンブリュウナ) [19]

**: *Ctenopharyngodon idellus* (グラシイギョ) [15, 17]

Cyprinidae (コイ科)

Gnathopogon elongatus elongatus (field gudgeon, タモコ) [23]

Gnathopogon elongatus suwae (Suwa gudgeon, スワモコ) [9]

*Hemibarbus labo* (barbell steed, コウライニギョ) [25]

*Pseudorasbora parva* (topmouth gudgeon, モッコ) [2, 3, 5]

*Tricholodon hakonensis* (Japanese dace, ウグイ) [17, 20]

*Zacco temminckii* (dark chub, カワムツ) [26]

Cobitidae (ドジョウ科)

*Misgurnus anguillicaudatus* (Oriental weatherfish, ドジョウ) [2, 3, 5]

Siluriformes (ナマズ目)

Bagridae (ギギリ科)

**: *Pseudobagrus tokiensis* (as *Pseudobagrus aurantiacus*) (cuttailed bulhead, ギバチ) [9]

Siluridae (ナマズ科)

*Silurus asotus* (Amur catfish, ナマズ) [26]

Salmoniformes (サケ目)

Pleuronectidae (アユ科)

**: *Plecoglossus altivelis altivelis* (as *Plecoglossus altivelis*) (ayu, アユ) [3, 5]

Salmonidae (サケ科)

**: *Oncorhynchus mykiss* (as *Salmo gairdneri*) (rainbow trout, ニジマス) [15, 17, 18, 20]
New hosts for *Lernaea cyprinacea* and a checklist of Lernaeidae

*Salmoneidae* gen. sp. (trout, 「マス類」) [15]

Gasterosteiformes (トゲウオ目)
Gasterosteiidae (トゲウオ科)

*Pungitius pungitius* (as *Pungitius pungitius pungitius*) (ninespine stickleback, イバラトミヨ) [20]

Cyprinodontiformes (カダヤン目)
Poeciliidae (カダヤシ科)

*Poeciliidae* gen. sp. (livebearer, 「卵胎生メダカ科」) [17]

Beloniformes (ダツ目)
Adrianichthyidae (メダカ科)

*Oryzias latipes* (Japanese rice fish, メダカ) [3, 5, 6, 11, 14, 15, 16, 17]

Perciformes (スズキ目)

Centrarchidae (サンフィッシュ科)

*Lepomis macrochirus* (bluegill, ブルーギル) [24, 25]

*Micropterus salmoides* (largemouth bass, ブラックバス) [15]

Cichidae (カワアメ科)

**Pterophyllum scalare** (freshwater angelfish, エンゼルフィッシュ) [17]

Gobiidae (ハゼ科)

*Chaenogobius macrognathos* (edohaze, エドハゼ) [3]

*Gymnogobius laevis* (as *Chaenogobius laevis*) (jyuzukakehaze, ジュズカケハゼ) [20]

*Tridentiger obscurus* (dusky tripletooth goby, チチブ) [15]

Channidae (タイワンドジョウ科)

*Channa argus* (snakehead, ハムルチー) [15]

Unknown fish [7]

Amphibia (両生類)

Caudata (有尾目)

Salamandridae (イモリ科)

*Cynops pyrrhogaster* (as *Diemictylus pyrrhogaster*) (Japanese fire belly newt, アカハライモリ) [4]

Anura (無尾目)

Ranidae (アガエル科)

*Rana catesbeiana* (as *Rana catesbiana*) (tadpole) (American bullfrog, ウシガエル幼生) [4]

Sites of infection: skin, fins, buccal cavity, gills

Distribution (Fig. 2): Hokkaido, Ibaraki, Gunma, Chiba, Tokyo, Kanagawa, Nagano, Shizuoka, Toyama, Gifu, Aichi, Shiga, Mie, Nara, Osaka, Hyogo, Okayama, Shimane, Hiroshima, Yamaguchi, Kagawa, Nagasaki, Miyazaki


Remarks: Leigh-Sharpe (1925: 251) reported "Pseudorasbora angullicaudatus" as one of the hosts for L. cyprinacea (as L. elegans) in Japan. However, the scientific name of this host was definitely an error: the names of two different fish species, Pseudorasbora parva and Misgurnus anguillicaudatus, were mistakenly combined. Similarly, Matsui and Kumada (1928: 102) made the same mistake in reporting the host species in the English abstract of their paper although these authors clearly separated the two fish species in the Japanese text.

Fig. 2. Map of Japan showing the distribution of Lernaea cyprinacea. The copepod has been recorded from 23 prefectures (stippled). Prefectural names are arranged in alphabetical order: Aichi-24; Akita-7; Aomori-3; Chiba-15; Ehime-41; Etorofu Island-1; Fukui-26; Fukuoka-43; Fukushima-10; Gifu-23; Gunma-14; Hiroshima-37; Hokkaido-4; Hyogo-33; Ibaraki-12; Ishikawa-25; Iwate-6; Kagawa-39; Kagoshima-49; Kanagawa-18; Kochi-42; Kumamoto-47; Kunashiri Island-3; Kyoto-29; Mie-28; Miyagi-8; Miyazaki-48; Nagano-20; Nagasaki-45; Nara-30; Niigata-11; Oita-46; Okayama-35; Okinawa-50; Osaka-31; Saga-44; Saitama-16; Shiga-27; Shikotan Island-2; Shimane-36; Shizuoka-21; Tochigi-13; Tokushima-40; Tokyo-17; Tottori-34; Toyama-22; Wakayama-32; Yamagata-9; Yamaguchi-38; and Yamanashi-19.
New hosts for *Lernaea cyprinacea* and a checklist of Lernaeidae

There is no record of *L. cyprinacea* in the northern part of Honshu, the main island of Japan (Fig. 2). This is because there have been few surveys on the parasitic copepods of freshwater fishes in this region and also because the culture of warm-water fishes is not common there.

*Lernaea parasiluri* Yü, 1938 (ナマズイカリムシ：新称)

Synonym: *Lernaea parasiluri* Yamaguti, 1939
Host: *Silurus asotus* (as *Parasilurus asotus*) (Amur catfish, ナマズ)
Site of infection: gills
Distribution: Nagano
Record: Yamaguti 1939 (Nagano: Lake Suwa)
Remarks: Yamaguti (1939) described *Lernaea parasiluri* as a new species from the Amur catfish *Silurus asotus* from Lake Suwa without knowing the description of the same species by Yü (1938) from the same host species in China. Hu (1948) regarded both taxa as conspecific. In China, the species has been recorded by some other scientists as well (Yin, 1962; Wang, 1964; Kuang and Qian, 1991). Ho (1961) reported intraspecific morphological variations in the holdfast processes of the species from Taiwan. The copepod is known to occur in the Amur River basin, Far Eastern Russia (Dogiel and Akhmerov, 1952; Markevich, 1956; Gusev, 1987) but there has been no record from Korea to date (Kim, 1998; Kim and Choi, 2003). In Japan, Yamaguti's (1939) paper is the only published work and we need more research into the biology of the species.

Genus *Lamproglena* von Nordmann, 1832 (ヒメイカリムシ属：新称)

*Lamproglena chinensis* Yü, 1937 (ヒメイカリムシ：新称)

Synonym: *Lamproglena ophiocephali* Yamaguti, 1939
Host: *Channa argus* (as *Ophiocephalus argus*) (snakehead, カムルチー)
Site of infection: gills
Distribution: Gifu, Shiga, Kyoto
Records: 1. Yamaguti 1939 (Kyoto: Kizu River); 2. Anonymous (Gifu: a tributary of the Kiso River); 3. Grygier and Urabe 2003 (Shiga: Lake Biwa)
Remarks: As in the case of *Lernaea parasiluri*, Yamaguti (1939) described *Lamproglena ophiocephali* as a new species from the snakehead *Channa argus* (as *Ophiocephalus argus*) from the Kizu River (as River Kizu) without referring to the description of *Lamproglena chinensis* by Yü (1937) from the same host species in China. There are some other records of the latter species from China (Sproston et al., 1950; Yin, 1962; Wang, 1964; Chen, 1973; Kuang and Qian, 1991). Both taxa were synonymised by Sproston et al. (1950) although Yamaguti (1963) listed them as independent species in his monograph. We herein regard *L. ophiocephali* to be a junior synonym of *L. chinensis* because there are no substantial differences in the morphology of the specimens described by Yü (1937), Sproston et al. (1950) and Yamaguti (1939). In Japan, there has been no further description of the species since the work of Yamaguti (1939) and in the current records (Anonymous, 2002; Grygier and Urabe, 2003) there is only information on the host and locality. Therefore, a redescriptions of the species using newly collected specimens from Japan is desired. In East Asia, it has also been reported from Far Eastern Russia (Amur River basin) (Dogiel and Akhmerov, 1952; Markevich, 1956; Smirnova, 1971;
Gusev, 1987) and Korea (Kim, 1998; Kim and Choi, 2003). *Channa argus* was introduced into Japan from Korea around 1923-1924 (Nakamura, 1939; Maehata, 1989); it is highly likely that the copepod was also introduced into Japan on *C. argus* (Grygier and Urabe, 2003).

**Future Research into *Lernaea cyprinacea* in Japan**

The above checklist shows that *L. cyprinacea* has been reported in Japan from 33 or 34 species and subspecies of fishes belonging to 17 families in 10 orders and also from 2 species of amphibians from 2 families in 2 orders. Due to its low host specificity, the copepod may be found on some other freshwater fishes in Japan. The species is known to infect frogs and their tadpoles in China (Yin et al., 1963) and U. S.A. (Tidd and Shields, 1963; Wellborn and Lindsey, 1970) as well as Japan.

The taxonomy of the Japanese *L. cyprinacea* needs further research in relation to *L. elegans*. Although Harding (1950) regarded these two species as identical, there is an opinion, based on the experiments made in Russia (Poddubnaya, 1973, 1974), that *L. elegans* is a different species from *L. cyprinacea* (see Kabata, 1979: 142-155). Since *L. elegans* was originally described from Japan (Leigh-Sharpe, 1925), detailed morphological study of copepods is strongly desired using specimens from this country and from experimental infections. The descriptions of the European *L. cyprinacea* (Grabda, 1963; Kabata, 1979; Boxshall et al., 1997) may be useful in reconsidering the taxonomic status of *L. cyprinacea* and/or *L. elegans* in Japan.

Because of its importance as a pathogen, various studies have been conducted in Japan on the species infecting important cultured fishes, such as the common carp *Cyprinus carpio* and the Japanese eel *Anguilla japonica*, and much knowledge on the biology and control has been accumulated (Nakai, 1927; Matsui and Kumada, 1928; Nakai and Kokai, 1931; Kasahara, 1962). However, there is yet very limited information on the ecology of the species occurring in wild fish populations in rivers and lakes. Much remains to be studied in natural waters on the host utilization, population dynamics, and differences in infection level related to environmental factors.

*Lernaea cyprinacea* has potential as an experimental animal because a population of the species can be easily maintained in a small tank with small fish like the Japanese rice fish *Oryzias latipes* (Kasahara, 1962). It is thus highly expected that information on its biology is obtained through experimental works.

There are some reviews on the biology and control of *L. cyprinacea* in Japan (e.g., Nakai and Kokai, 1930; Kasahara, 1965; Shiino, 1966; Egusa, 1978; Ogawa, 1983).

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New hosts for *Lernaea cyprinacea* and a checklist of Lernaeidae


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日本の新宿主と日本産イカリムシ科
カイアシ類の目録（1915〜2007年）

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要旨 広島県芦田川産コウライニゴイ Hemibarbus laboe とナマズ Silurus asotus, また同県黒瀬川産カワムツ Zacca temminckii よりイカリムシ Lernae cyprinacea を採集し, その形態を簡単
に記載した。コウライニゴイとカワムツはイカリムシの新宿主であり, ナマズはわが国における新
宿主である。コウライニゴイ（寄生部位：鰭）とカワムツ（背鰭）から得られたイカリムシは成体
雌, ナマズ（鰭）から得られた個体はコベボディド5期であった。1915〜2007年の93年間に出版さ
れた文献に基づいて, わが国におけるイカリムシ科カイアシ類3種（イカリムシ, ナマズイカリム
シ [新称] Lernaea parasiluri, ヒメイカリムシ [新称] Lamproglena chinensis）に関する情報（シ
モノム, 宿主, 寄生部位, 地理的分布）を整理し, 目録として示した。この整理により, イカリム
シはわが国では10目17科に属する33〜34種（亜種を含む）の魚類と2目2科に属する2種の両生類
から記録されていることが明らかになった。また日本産イカリムシの分類学的再検討を含む今後の
研究課題を示した。上記の新標準和名に加えて, Lamproglena 属に対してヒメイカリムシ属の新
標準和名を提唱する。

キーワード: Lamproglena chinensis; Lernaea cyprinacea; Lernaea parasiluri; イカリムシ; 寄生
虫; 新宿主